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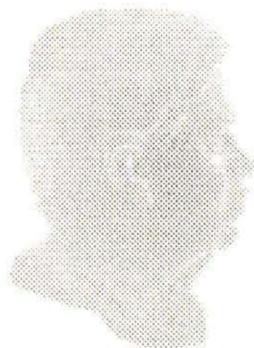

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Origin of the vortex antivortex superlatices in nanomagnetics

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We study the origin of the vortex-antivortex superlattices formation in nanomagnetics. Recently we have shown that the influence of strong spin-polarized current passing perpendicularly to the vortex state nanodisk can produce a periodic vortex-antivortex lattices [1]. One can distinguish two critical current densities during the lattice formation process: When $j<j_1$ the stationary state of the system is a deformed vortex state with negligibly small changes of the out-of-plane magnetization and appreciably deformed in-plane one. When $j<j_2$ the system goes in a saturation state with all spins aligned along z-axis. When $j_1<j<j_2$ a rich variety of dynamic states is observed: the system demonstrates either chaotic dynamics of vortex-antivortex 2D gas or regular stable vortex-antivortex structures. Near the critical current j_2 the only square vortex-antivortex lattices appear in the system. The origin of such lattice formation is a loss of stability of the current saturated state when the current decreases. Using the Fourier technique we develop the linear theory of instability of the saturated state $m_z=1$ and find the instability region, i.e. the region of superlattice existence:

$$j(q) < \sqrt{\left(1 - l^2 q^2\right)\left(l^2 q^2 - 1 + \frac{qh - 1 + e^{-qh}}{qh}\right)} \quad ,$$

where q is absolute value of the wave vector, his sample thickness, l is exchange length and j is normalized current density. This dependence is well pronounced by simulations [2].

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- O.M. Volkov, V.P. Kravchuk, D.D. Sheka, Yu. Gaididei, Phys. Rev. B, **84**, 052404 (2011).
- All simulations were performed on the computing cluster of Taras Shevchenko University http://cluster.univ.Kyiv.ua/ using OOMMF micromagnetic modeling code.